REPORT DOCUMENTATION PAGE

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4. TITLE AND SUBTITLE	5. FUNDING NUMBERS
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6. AUTHOR(S)

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7. PERFORMING ORGANIZATION N.	8. PERFORMING ORGANIZATION REPORT NUMBER
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11. SUPPLEMENTARY NOTES

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13. ABSTRACT (Maximum 200 words)

One major project has been finished and two important projects were well underway when funds were cut off. I. The finished work, dealing with cross sections for scattering from defects on surfaces, will be a classic work, since the definition of the cross section had not been done properly before. II. The second project has to do with trapping and sticking coefficients in low and medium energy collisions of atoms and molecules with surfaces. Our aim is to lay to rest the long standing debate regarding the low energy asymptotic limit of sticking coefficients: is it 0? or 1? III. A student was looking at improvements to the wavepacket code for atom surface collisions, He also had started a project involving atom scattering with a vibrating adatom on a surface. IV. Another unfinished project is inspired by some data that Tom Engel has generated on scattering of helium from stepped surfaces. He sees, at certain angles aimed into the steps, a scattering in non-Bragg directions, even though there is supposedly little or no disorder. The scattering is at half the momentum transfer of the perfect surface and rather broad, suggesting that perhaps steps of twice the usual length are involved.

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Final Project Summary- Eric. J. Heller

We have developed the theory for cross sections for scattering from defects on corrugated surfaces. Just as in the gas phase, one needs to have a definition of what is meant by the "size" of an object, as measured by collisions. The history of this problem has been fraught with mistakes and misconceptions. The correct definition of such cross sections had not been given before. The theory allows a rigorous measurement of the "size" of a defect or of an adsorbate, etc, on a surface. The optical theorem was derived for the case of scattering from a corrugated surface. It is interesting in that the "forward" scattering of the textbook optical theorem becomes the Bragg scattering. The optical theorem again is the flux conserving law which states that flux lost from the Bragg directions is recovered as diffuse scattering in between.

The theory was applied successfully to the system CO on Pt (111), resolving a long standing controversy on whether CO is much "larger" on a surface than in the gas phase. In fact it is only slightly "larger".

Another project has examines trapping and sticking coefficients in low and medium energy collisions of atoms and molecules with surfaces. Our aim has been to lay to rest the long standing debate regarding the low energy asymptotic limit of sticking coefficients: Is it 0? or 1? This project is about 2/3 completed. The issue of sticking at low temperatures and low collision energy has important space physics applications.

Finally, the wavepacket code for atom surface collisions has been significantly enhanced. Faster means of propagation have been developed. We have begun a project involving atom scattering with a vibrating adatom on a surface.

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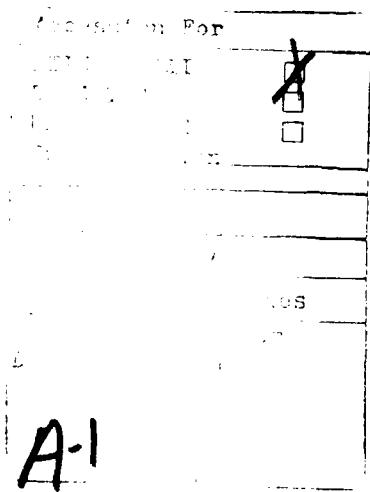
Final Report- Eric. J. Heller

One major project has been finished and two important projects were well underway when funds were cut off.

I.   The finished work, dealing with **cross sections for scattering from defects on surfaces**, will be a classic work, since the definition of the cross section had not been done properly before.   Anyone wishing to measure the "size" of a defect or of an adsorbate, etc, on a surface will need the formula and methods developed by us. Coworkers: Daniel Huber, postdoc; Han Xu, student.

Details:

The first paper is finished, dealing with (1) the definition of the cross section of a defect on a surface, and (2) specifically the system CO on Pt (111). We could have easily split this into two papers, namely a theory paper and an application paper, and this would have surely helped us with those who count papers and don't assess them for quality and impact.

No one has ever defined the cross section for surface defect scattering on a corrugated surface before; we believe our work to be a real landmark in this respect. Just as in the gas phase, we need to have a definition of what is meant by the "size" of an object. The history of this problem has already been fraught with misconceptions.

The calculations of CO on Pt (111) have been successful, and compare well with the experiments. Semiclassical wavepackets have been used to perform the calculations. More details are to be found in the manuscript.

II.   The second project has to do with trapping and **sticking coefficients in low and medium energy collisions of atoms and molecules with surfaces**. Our aim is to lay to rest the long standing debate regarding the low energy asymptotic limit of sticking coefficients: Is it 0? or 1? This project was about 2/3 completed, when funding was cut off.   Coworker: John Frederick, Postdoc.

Details:

The issue of sticking at low temperatures and low collision energy has important space physics applications. Moreover, it has important experimental consequences since atoms can be dropped onto surfaces at very low velocity using laser atom traps with gravity as the accelerating agent.

III. A student, Colin Wright (grad student, physics) was looking at **improvements to the wavepacket code** for atom surface collisions. He also had started a project involving atom scattering with a vibrating adatom on a surface. When his funding AFOSR was cut off, he left graduate school. The project is now in limbo.

IV. Another unfinished project is inspired by some data that Tom Engel has generated on **scattering of Helium from stepped surfaces**. He sees, at certain angles aimed into the steps, a scattering in non-Bragg directions, even though there is supposedly little or no disorder. The scattering is at half the momentum transfer of the perfect surface and rather broad, suggesting that perhaps steps of twice the usual length are involved.

1. H. Xu, D.P. Huber and E.J. Heller, "Cross Section and Optical Theorem for Defects on a Corrugated Surface," *J. Chem. Phys.*, **89**, 2550 (1988)

UW # 62-5263

FINANCIAL STATUS REPORT
(Follow instructions on the back)

1. FEDERAL AGENCY AND ORGANIZATIONAL ELEMENT TO WHICH REPORT IS SUBMITTED
U.S. AIR FORCE

2. FEDERAL GRANT OR OTHER IDENTIFYING NUMBER
AFOSR-87-0075

OMB Approval No. 80-R0180

3. RECIPIENT ACCOUNT NUMBER OR IDENTIFYING NUMBER
62-5263

4. EMPLOYER IDENTIFICATION NUMBER
1916001537A1

PAGE 1 of 1

5. Recipient Organization
University of Washington
EEC Accounting #62-5263
3917 University Way NE - ND-22
Seattle, Washington 98195

6. FINAL REPORT: ☒ Yes ☐ No
7. BASIS: ☐ Cash ☒ Accrual

8. PROJECT/GRANT PERIOD
From: 11/1/87   To: 10/31/89

9. PERIOD COVERED BY THIS REPORT
From: 11/1/88   To: 10/31/89

10. STATUS OF FUNDS

PROGRAMS/FUNCTIONS/ACTIVITIES ►	(a)	(b)	(c)	(d)	TOTAL (f)
a. Net outlays previously reported	$195,736.00	$	$	$	$
b. Net outlays this report period	96,764.00				
c. Less: Program income credits	-0-				
d. Net outlays this report period	96,764.00				
e. Net outlays to date	292,500.00				
f. Less: Non-Federal share of outlays	-0-				
g. Total Federal share of outlays	292,500.00				
h. Total unliquidated obligations	-0-				
i. Less: Non-Federal share of unliquidated obligations	-0-				
j. Federal share of unliquidated obligations	-0-				
k. Total Federal share of outlays and unliquidated obligations	292,500.00				
l. Total cumulative amount of Federal funds authorized	292,500.00				
m. Unobligated balance of Federal funds	-0-				

11. INDIRECT EXPENSE
Type of Rate: ☐ Provisional ☐ Predetermined ☐ Final ☐ Fixed
a. Rate: 44.5%
b. Base: $66,964.71
c. Total Amount: $29,799.29
d. Federal Share: $29,799.29

12. CERTIFICATION
I certify to the best of my knowledge and belief that this report is correct and complete and that all outlays and unliquidated obligations are for the purposes set forth in the award documents.

SIGNATURE OF AUTHORIZED CERTIFYING OFFICIAL

TYPED OR PRINTED NAME AND TITLE
Fred H. Bailey, Director

TELEPHONE (Area code, number and extension)
206 543-0951

DATE REPORT SUBMITTED
1/12/90